CS 543: Computer Graphics
Lecture 9 (Part III): Raster Graphics: Manipulating Images

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Manipulating Pixmaps

- Pixmap = rectangular array of numerical values
- Pixmap copied to frame buffer = rendered
- Change frame buffer entry = onscreen picture changes
- Each pixel location has fixed number of bits (color depth)
- Example: if color depth is b bits, can store up to 2^b values

Manipulating Pixmaps

- Operations of interest:
    - Copying pixmaps
        - glReadPixels: frame buffer to off-screen memory
        - glDrawPixels: pixmap to frame buffer
        - glCopyPixels: frame buffer to frame buffer
        - memCopy: off-screen to off-screen
    - Comparing pixmaps
    - Representing and coloring regions in pixmap

Manipulating Pixmaps

- Data types for pixmaps
  - Bitmap: 1 bit, on or off
  - Gray scale: one byte, values 0-255
  - RGB: 3 bytes (red, green, blue)
  - RGBA: 4 byte (red, green, blue, alpha)
- Declaration of RGB triple:

```
class RGB{
   public: unsigned char r, g, b;
};
```

RGBpixmap Class

- OpenGL convention: pixmap (bottom to top, left to right)
- Add draw, read and copy methods (which use openGL)

```
Class RGB{
    public: unsigned char r, g, b;

    RGBpixmap( ); // constructor
    void setPixel(int x, int y, RGB color);
    RGB getPixel(int x, y);
    void draw( ){ glDrawPixels(nCols, nRows, GL_RGB,
                            GL_UNSIGNED_BYTE, pixel);
    void read( ){glReadPixels(x, y, nCols, nRows, GL_RGB,
                            GL_UNSIGNED_BYTE, pixel);
```

RGBpixmap Class

```
// ..... contd.

  void copy( ){ glCopyPixels(.. Parameters..);

  int readBMPFile(char *fname);
  void writeBMPFile(char *fname);
};
```
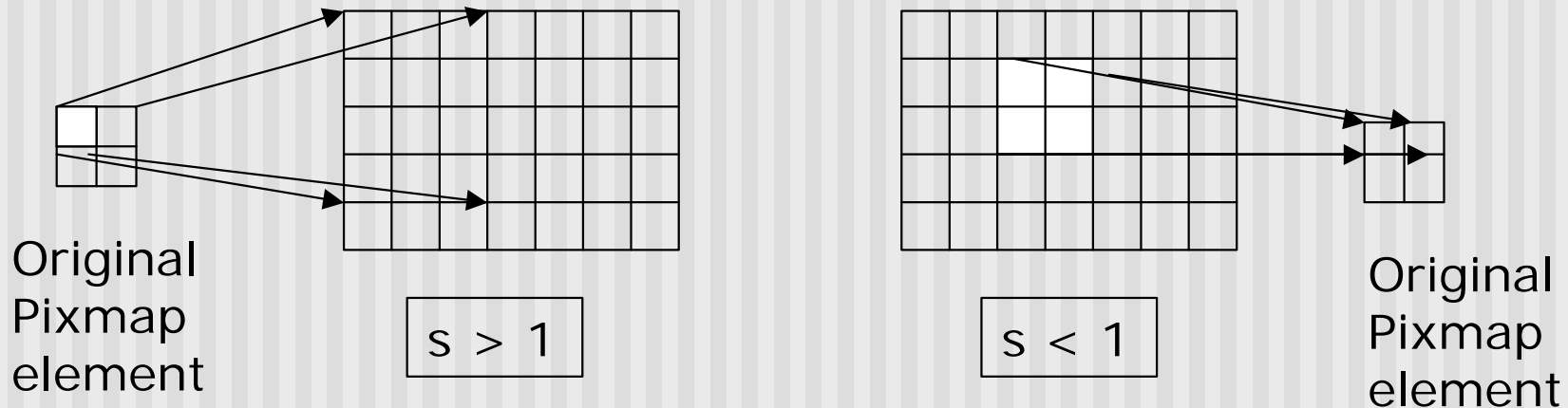
Note: refer to Hill fig. 10.3 for full RGBPixmap declaration

Scaling and Rotating Images

- Scaling: want a pixmap that has s times more pixels in x, y
  - s > 1: enlargement
  - s < 1: reduction (information is lost!)

Original Pixmap element

s > 1

s < 1

Original Pixmap element

- openGL scaling:
  - **`glPixelZoom(float sx, float sy)`**
  - Sets scale factors for drawing pixmaps
  - Note: pixmaps not scaled, pictures drawn are scaled

Scaling and Rotating Images

- glPixelZoom(float sx, float sy)
  - Sets scale factors for subsequent glDrawPixels command
  - Scaling is about current raster position, pt.
  - Pixel row r and column c of pixmap
  - Drawn as rectangle with bottom left current screen coordinates
  - Draws (pt.x + sx*r, pt.y + sy.c)
- 90, 180 and 270 degree rotations:
  - Copy one pixmap to another doing matrix transposes
- General rotations:
  - affine transform of pixmap points to get new pixmap

Combining Pixmaps

- Two pixmaps A and B combined pixelwise to form third pixel C
- i.e. $C[i][j] = A[i][j] \otimes B[i][j]$
- Averaging:
    - $C[i][j] = \frac{1}{2} * (A[i][j] + B[i][j])$
- Subtraction:
    - $C[i][j] = A[i][j] - B[i][j]$
- Generalized weighting:
    - $C[i][j] = (1-f).A[i][j] + f.B[i][j]$

Combining Pixmaps

- Generalized weighting:
  - $C[i][j] = (1-f).A[i][j] + f.B[i][j]$
- Example:
  - $A = (14, 246, 97)$, $B = (82, 12, 190)$, $f = 0.2$
  - $C = (27, 199, 115) = 0.8\ A\ +\ 0.2\ B$
- Question: How to dissolve image A into B?
- Raster demo!!

Alpha Channel and Image Blending

- Even more generalized weighting = blending/compositing
- Blending:
  - draw partially transparent image over another
  - Add 4th component, alpha value (A) to RGB
  - Interpretation: alpha specifies how opaque each pixel is
  - Transparent (A = 0), Total opacity (A = 255)
  - Alpha most frequently used in scaling colors
- Alpha channel: series of alpha values in a pixmap

```
class RGB{

        public: unsigned char r, g, b,a;

};
```

References

- Hill, chapter 9